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Report No. 1

1. Title: (6) Development of the S.A.M. Steadiness Aiming Test, Form B, for use in the selection and classification of aircrew personnel.

2. Object: To develop a test for measuring the steadiness of a candidate's hand while performing the simple task of aiming a pivoted stylus.

3. Conclusions and recommendations:

The S.A.M. Steadiness Aiming Test, Form B, proved to be a mechanically satisfactory measure of hand steadiness. The test had excellent reliability. Validity of the test, however, was very low for prediction of success in elementary pilot training. The addition of a verbal stress element to the S.A.M. Steadiness Aiming Test did not result in an increase in validity.

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(917100)

Discussion:

General Description

The S.A.M. Steadiness Aiming Test, Form B, is designed to measure steadiness of a candidate's hand while performing the simple task of aiming a pivoted rod or stylus. The psychomotor ability thus being tested is that of steadiness combined with simple arm-hand coordination. In general design the test is an adaptation of a simpler S.A.M. Steadiness Test, Form B, described in AAF School of Aviation Medicine, Research Report No. 1, Project No. 95. The most significant modification from this earlier test is the use of a pivoted stylus, resulting in a considerable alteration of the candidate's task. By the substitution of a different stylus, stylus support, and target disc, the S.A.M. Steadiness Aiming Test, Form B, can be converted into the simpler S.A.M. Steadiness Te t, Form B.

The nature of the S.A.M. Steadiness Aiming Test and the task required of the candidate are illustrated in the accompanying photographs and sketches. Figure 1 shows a diagonal side view of the candidate's test unit. Figure 2 provides a sketch of the more important structural details with pertinent dimensions. The stylus consists of a steel rod (0.1 inch in diameter), to one end of which a small handle is attached by a ball and socket swivel joint. Attached to the other end of the stylus is a section of silver rod (0.75 inch long, 0.125 inch in diameter) extending through a target aperture (0.375 inch in diameter) in a silver plate. At a distance of 1.75 inches from the handle and 6 inches from the target a crossbar of the stylus is pivoted upon a simple fulcrum support. Thus, movements of the handle become magnified at the target end of the stylus. In order for the fulcrum to permit horizontal, as well as vertical movements, the crossbar of the stylus rests in a rounded rather than notched depression in the fulcrum support.

During the administration of the test the task of the subject is to hold the stylus handle, and try to keep the end of the stylus from touching the edge of the target aperture. Whenever contact of the stylus with the edge of the target occurs, an electrical counting mechanism is energized. Thus, the greater the unsteadiness of the candidate's hand while aiming the stylus, the greater will be the number of contacts with the edge of the target, and the higher his total score. In order for prolonged contacts to result in a more severe penalty than momentary ones, the current to the stylus is broken 250 times per minute by a circuit interruptor. Approximately four counts are therefore recorded on the electrical recording mechanism for each second of prolonged contact. A red signal light just above the target flashes once as each count is registered by the scoring mechanism. In this way the candidate is informed whenever an error is recorded against him.

The use of a pivoted stylus requires some means of preventing the subjects from pulling or pushing on the handle, since this would result in greater stability of the stylus. The present apparatus is designed so that either pushing or pulling on the handle will dislodge the stylus from its insulating fulcrum support, so that the stylus crossbar makes contact with one of the metal rings at either end of the insulating stylus support. The electrical circuit is arranged so that contact with either of these metal surfaces closes the circuit of the electrical recording

mechanism.

In the administration of the S.A.M. Steadiness Aiming Test, four candidate's test units are connected to a single control unit that can be operated by one examiner. The four candidate's test units are located on one of the standard test tables provided for this and other AAF School of Aviation Medicine psychomotor tests. The control mechanism is mounted in one of the standard psychomotor control desks. A picture of the control unit and desk is provided in Figure 3, which shows the location of the counters, switches, and control signal lights. All electrical connections between test panels, test table, and control desk are by means of plug-in connections.

Description of Mechanism

A wiring diagram of the electrical recording system is shown in Figure 4. The operation sequence is as follows:

Contact of the stylus (St) with the target (T) closes the electrical circuit through the coil of the relay (Ry). In the closed position one arm of the relay completes the circuit to the Veeder electro-magnetic counter (VC), while the other relay arm completes the circuit to the signal light (L1). It will be noted that this operation of the relay, counter and signal light will also result from contact of the stylus with the metal ring in the insulated stylus support.

The relays and counters operate on 6 V.D.C. The signal light operates on 115 V.A.C. The use of the relay in the electrical counter circuit is necessary because sparking of the current (about 3.0 amp. at 6 V.D.C.) drawn by the counter would cause rapid deterioration of the contact surfaces of the stylus and target. The relay, by comparison, draws approximately 0.3 amp. Further protection of the contact surfaces is provided by a condenser-resistor spark suppressor, and by the use of silver at the points of contact. A condenser-resistor spark suppressor is also used across the relay contacts which control the electro-magnetic counter. The direct current for the operation of the relays and counters is provided by one rectifier unit, a Stancor Power Pack (P.P.) for each four test units.

In the control unit of the Steadiness Aiming Test a switch is provided for the A.C. power supply. This is the left hand switch in Figure 3, labelled "POWER" (Sw1 in the wiring diagram of Figure 4). Turning on the power switch starts the motor of the circuit interruptor and lights a red signal lamp just ahead of this switch on the control table. Beyond the power switch is a pair of 10 amp. fuses shown in the wiring diagram (F). In the direct current line from the power pack is another switch, shown at the right of the control table in Figure 3, and labelled "MAIN STARTING CONTROL" (Sw2 in the wiring diagram). Turning on this switch supplies current to the styli of the candidate's test panels and to a white signal light (L2 in wiring diagram) located just ahead of the switch. Since the direct current from the power pack is interrupted 250 times per minute by the circuit interrupter, the white signal light flashes at this rate. The white signal light thus provides a means of checking the proper operation of the circuit interrupter. The other four switches on the control table (L3 in the wiring diagram) control the individual test units.

The circuit interrupter mechanism of the Steadiness Aiming Test consists of a synchronous motor (M in Figure #) turning a cam (Cm) at a rate of 10 r.p.m. This cam, with 25 raised studs, briefly opens a microswitch 250 times per minute. For operation on 50 cycle current, a cam with 30 studs is provided to make up for the reduced speed of the synchronous motor.

Installation Instructions

The individual candidate's test panels are to be plugged into the test tables in the plug receptacles provided for this purpose. The four 6-conductor connecting cables with attached sockets are for the connections from the test to the control desks (only four of the six wires in the cables are actually used for this test). The plug receptacles on the control table are numbered according to the corresponding counters (in the order from left to right) on the control desk. By the arrangement of the connections between the test and control tables the counter numbers can be made to correspond to any desired positions on the test table. A two-connector plug receptacle at the side of the control desk is for the connection to the 115 V.A.C. power source, for which purpose a two-conductor cable with the proper socket and plug attachments is provided. The power pack should be placed in the control desk and leads attached. After all these connections have been properly made, the apparatus is ready for operation. The control table should be placed with the back toward the test table, so that none of the candidates will be in a position to see the counters during the testing.

For proper administration of the Steadiness Aiming Test, the chairs should be placed according to fixed positions marked on the floor of the test room. It is essential that all candidates have their arms extended full length while taking the test. The proper position of the chairs is that at which candidates with the longest arms will be able to take the test with their arm completely extended, yet without having their shoulders resting against the back of the chair. The candidates with shorter arms will be required to take a position farther forward on the chair, or to lean forward. Obviously, this procedure necessitates keeping the candidates' test panels at a fixed position on the test table.

Maintenance of Apparatus

Motor lubrication: The motor of the circuit interrupter should be oiled once weekly. Two oil holes at the top of the motor (outlined in red) should be given one or two drops of light, high grade machine oil. Because of the location of the cam, these oil holes are not readily accessible. In locating the o holes the use of a flashlight may be necessary.

Adjustment of Circuit Interrupter: The circuit interrupter should give rhythmic interruption of the direct current to the stylus at a rate of 250 times per second. The functioning of this mechanism may be checked either by watching the white signal light or by turning on one of the test units with the stylus making good contact with the target. The interruptions should be rhythmic, and at the above specified rate. Any failure will probably be due to maladjustment of the microswitch operated by the

cam. This can be changed by loosening the two screws by which the switch is held in position and raising or lowering the roller end of the switch sufficiently to give the necessary on and off operation.

Cleaning of contact surfaces: The contact surfaces of the stylus and target should be cleaned twice daily with carbon tetrachloride. If prolonged use results in pitting of these surfaces, they should be rubbed with crocus cloth.

Replacement of lamps: For replacement of the lamps in the candidate's test panels it is necessary to remove the jewel at the front of the lamp assembly. To do this requires a tight grip, counter-clock-wise twist, and pull on the jewel rim. The lamps in the control table can be replaced after removal of the clip-in sockets. All lamps in the A.C. circuit are Mazda, type S-6. The signal lamp in the D.C. circuit should be replaced only by a lamp designed for 6-8 volts, and drawing 0.25 amperes.

Replacement of target aperture disc: Should it be necessary to replace the target aperture disc by a new one or by another of different size, the correct procedure is as follows: The wire lead from the target disc should first be disconnected from the terminal strip at the back of the test panel. Access to this is obtained through the bottom of the panel. It is then possible to unscrew and remove the large nut at the back of the target disc and phenolic container. The disc and container can then be slipped forward out of the hole in the sheet metal housing and replaced. Removal of the silver target disc from the phenolic container should not be attempted.

Conversion of S.A.M. Steadiness Test, Form B, into S.A.M. Steadiness Aiming Test, Form B: To make this conversion the following steps are necessary: To remove the stylus of the Steadiness Test the two nuts at the end, by which the wire lead is attached, must be removed. The stylus may then be removed from the target aperture, and the wire lead detached from the terminal strip. The stylus holder can then be removed and replaced with the Steadiness Aiming stylus support. The wire lead from metal rings of the stylus support must be connected to the same point on the terminal strip as the lead from the silver target disc. The lead from the stylus itself should be connected to the same point of the terminal strip to which the stylus of the Steadiness Test had been attached. For the Steadiness Aiming Test a target disc with a 3/8 inch aperture must be installed in the test panel according to the above described procedure.

Lining up test panel supports: A few test panels may be found on which the four rubber supports do not rest evenly on the table top, because of twisting of the sheet metal frame. This can be corrected by manually twisting the frame until all four points of support rest evenly on the table. Do not use a hammer or other forceful means in attempting to bend the sheet metal frame.

General repairs: Should any major repairs of the control unit ever become necessary, this can be done more conveniently if the control unit is removed from the control table. To do this the power pack should be disconnected and the panel at the side of the table unfastened and carefully maneuvered into the compartment inside the table. After the top panel is unfastened, the entire mechanism can then be lifted out of the table top.

Validation Results

The S.A.M. Steadiness Aiming Test, Form B, was used in the battery of psychomotor tests used for the classification and selection of aircrew personnel between 1 December 1942 and 1 November 1943. The test was modified, however, by the addition of verbal stress, and was called the Aiming Stress Test (CE211A). From 25 November through 28 November 1942, the S.A.M. Steadiness Aiming Test (without stress) was administered to 461 cadets on an experimental basis at Psychological Research Unit No. 2. Data are presented here for these 461 cadets, and also for two samples of 500 cadets tested between 8 December 1942 and 21 March 1943 on the Aiming Stress version of the test. All data presented here have been abstracted from Research Bulletin T44-8 of Psychological Research Unit No. 2.

Means and Standard Deviations of Individual Trials: In Table I are presented means and standard deviations for individual trials on the S.A.M. Steadiness Aiming Test and the Aiming Stress Test. It will be noted that the addition of verbal stress did not increase the difficulty of the test. It can be seen also from Table I that there is virtually no improvement through learning during the course of the 6 trials on the test.

Reliability: Reliability data are presented in Table II. Reliability is very high for both versions of the test.

Validity: Validity data are presented in Table II. It is evident from the data that the Aiming Stress Test has no significant validity for prediction of success in elementary pilot training. The S.A.M. Steadiness Aiming Test, on the other hand, appears to have slight validity, but the number of cases is insufficient to establish the validity accurately. The product moment correlation between the pilot stanine and the S.A.M. Steadiness Aiming Test (for 461 cadets) was found to be +.087 (sign reversed to indicate good performance on test associated with high stanine). Assuming that the validity of +.147 shown in Table II is accurate, the S.A.M. Steadiness Aiming Test, should have added approximately +.01 to the validity of the Psychological Classification Test Battery for prediction of success in elementary pilot training. (Aviation Psychology Technical Bulletin, Volume I, Bulletin 5.)

Project Personnel

This project was carried out under the direct supervision of Lt. Col. A. W. Melton, Chief, Department of Psychology. The development of the design of the S.A.M. Steadiness Aiming Test was primarily the work of Capt. W. F. Grether. The actual construction of the test and control units described in this report was done on contract by the Champion Pecan Machine Company of San Antonio, Texas. The contract arrangements were handled by Capt. J. Buel, who, with the assistance of Capt. J. S. Brown, worked very closely with the manufacturer on the details of the production model. Administration of the test at Psychological Research Unit No. 2 was under the supervision of Major M. P. Crawford. The report from which the data here reported were taken was prepared by 2nd Lt. J. W. Cowles.

APPENDIX

TABLE I

INDIVIDUAL TRIAL DATA ON THE S.A.M. STEADINESS AIMING TEST AND THE AIMING STRESS TEST

Trial No.	S.A.M. Steadiness Aiming Test N = 461		Aiming Stress Test N = 500 (43-I)		N = 500 (43-J)	
	M	σ	M	σ	M	σ
1	74.88	29.47	67.96	27.85	72.03	24.87
2	71.49	28.71	73.60	25.06	76.83	24.46
3	73.93	28.30	70.61	25.53	73.73	25.46
4	74.24	27.89	72.26	25.18	76.38	25.43
5	75.70	28.90	75.65	25.17	79.48	24.65
6	75.22	29.15	76.21	25.41	81.21	25.57

TABLE II

TOTAL TEST DATA ON THE S.A.M. STEADINESS AIMING TEST AND THE AIMING STRESS TEST

Scoring Method: Counter
Length of Trials: 40 seconds.
Rest between Trials: Variable, 10 to 20 seconds.
Number of Practice Trials: One 30 second trial.
Number of Test Trials: Six.
Testing Dates: 25-28 Nov 42, Steadiness Aiming Test; 2 Dec 42-21 Mar 43, Aiming Stress Test.
Validation Classes: Steadiness Aiming Test, Classes 43-H, I, J, and K. Aiming Stress Test, Classes 43-I and J.

Distribution and Reliability Constants

Test	N	M_t	σ_t	Reliability (Hoyt)
Steadiness Aiming	461	445.46	154.51	.95
Aiming Stress (43-I)	500	436.29	134.80	.94
(43-J)	500	459.66	127.39	.92

TABLE II - (Cont'd)

Validity Constants

Test	N_g	N_e	P_g	M_g	M_e	σ_t	r_{bis}*	r_{sta}*
Steadiness Aiming	261	200	.57	429.61	466.15	154.51	+.147	+.087
Aiming Stress (43-I)	330	170	.66	436.02	436.81	134.80	+.004	-
(43-J)	315	185	.63	459.50	459.94	127.39	+.003	-

* Signs reversed to indicate positive relationship between goodness of performance.

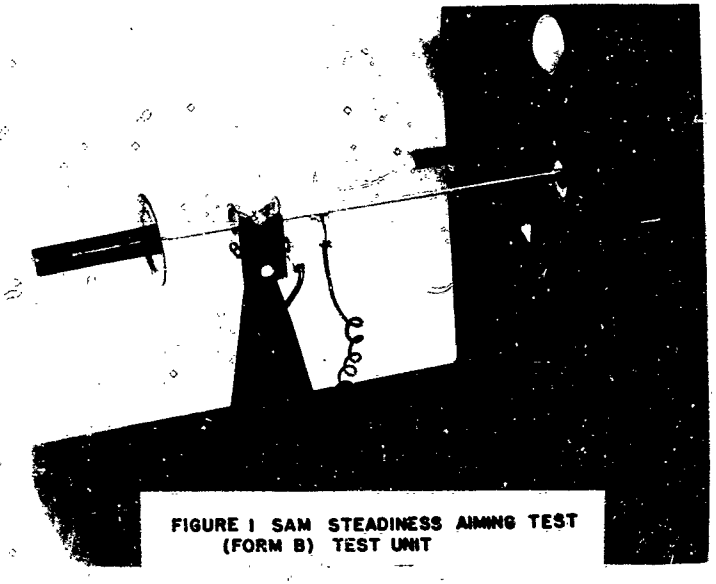

FIGURE 1 SAM STEADINESS AIMING TEST
(FORM B) TEST UNIT

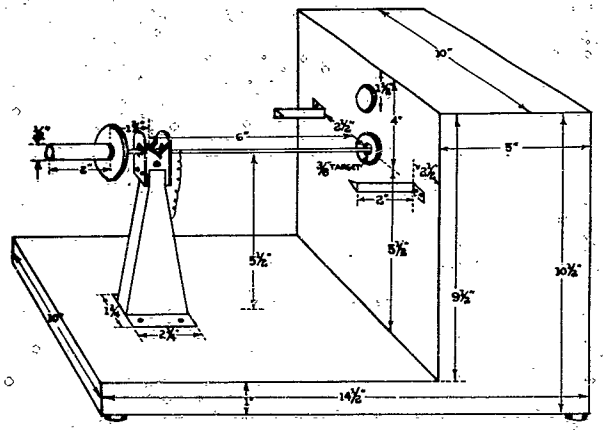

FIGURE 2 SAM STEADINESS AIMING TEST (FORM-B)
DIMENSIONS OF TEST UNIT W.P.M. 10/4/11

FIGURE 3 SAM STEADINESS AIMING TEST
(FORM B) CONTROL DESK

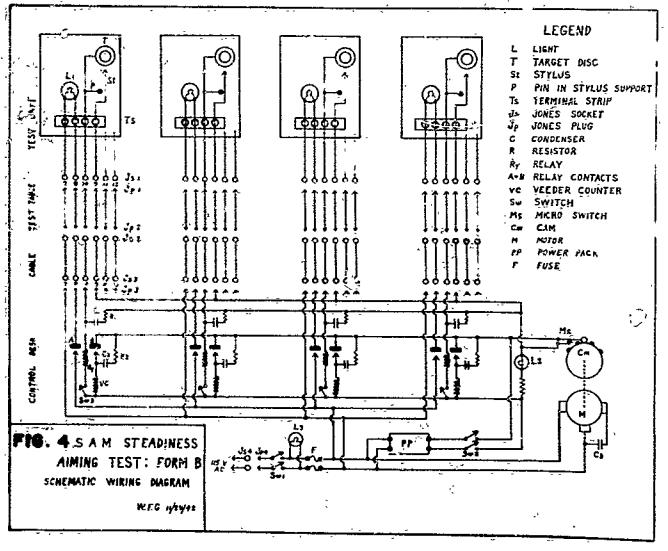

FIG. 4 S A M STEADINESS
AIMING TEST: FORM B
SCHEMATIC WIRING DIAGRAM
W.E.G. 1/9/41